(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 January 2003 (03.01.2003)

PCT

(10) International Publication Number
WO 03/000400 A1

(51) International Patent Classification⁷: B01J 8/02

(21) International Application Number: PCT/GB02/02520

(22) International Filing Date: 30 May 2002 (30.05.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0115296.6 22 June 2001 (22.06.2001) GB

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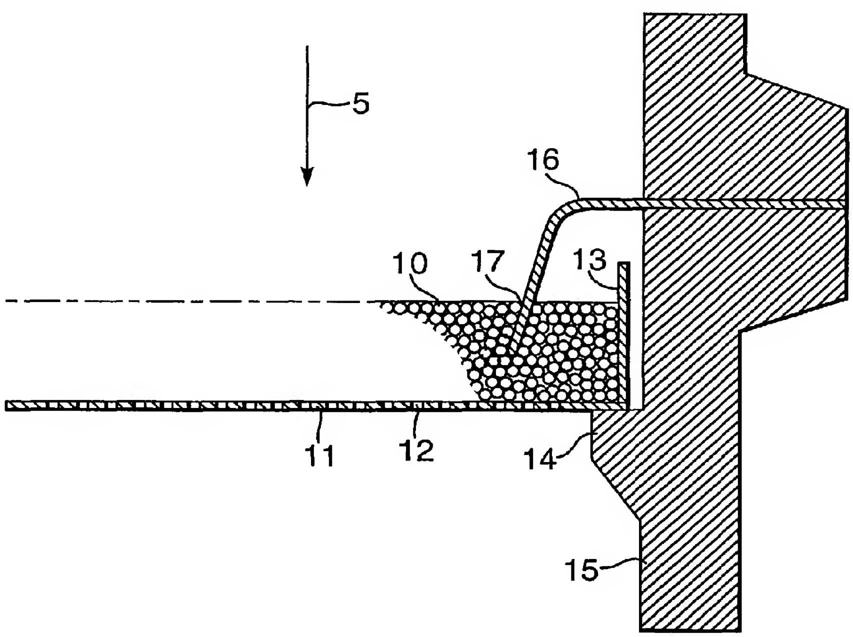
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR,

[Continued on next page]

(54) Title: CATALYST OR SORBENT BEDS



(57) Abstract: A fixed bed containing a catalyst or sorbent (10) having a deflector (16) to direct the flow of gas or liquid away from regions of higher permeability is described. The deflector (16) may for example be disposed around the edge of the fixed bed to direct the flow of gas or liquid away from the edge. The deflector improves the efficiency of the bed by preventing bypass of, e.g. ammonia through a bed of particulate ammonia oxidation catalyst.

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GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

<u>Catalyst or sorbent beds</u>

This invention relates to fixed beds of catalyst or sorbent and in particular, in order to increase the effectiveness of the bed, to means for directing the flow of a gas or liquid passing through the bed away from regions of the bed having a higher permeability.

Fixed catalyst and sorbent beds generally comprise at least one layer of a catalyst or sorbent with optionally an inert material, in the form of particles such as extrudates, pellets or granules supported by a perforate member such as a perforate plate, grid or mesh. By the term "sorbent" we necessarily include both adsorbent and absorbent materials. To pass through the bed, a gas or liquid must flow through the interstices or voids between the particles and the opposition to the flow causes a pressure drop to occur between one side of the bed and the other. Generally, it is recognised that the pressure drop across the bed should be as low as possible and hence the permeability of the bed should be high whilst at the same time providing sufficient contact time between the particles and gas or liquid to efficiently perform the catalysis or sorption processes. It is preferred that the flow of gas or liquid through the bed of catalyst or sorbent is uniform to provide consistent operation in terms of conversion in the case of a catalyst bed, or absorption in the case of an absorbent bed. To achieve this generally the size of the particles and thickness of the layer of particles is carefully controlled to achieve a uniform particle shape and size and a uniform permeability through the bed, through which the gas or liquid may flow.

A problem encountered with fixed beds containing particles of catalyst or sorbent is that where the particles make contact with the means for containing the bed and/or any member transecting the bed that is aligned with the flow of fluid through the bed, it has been found that the permeability is greater and hence the flow of gas or liquid through the bed is higher. In addition a further problem encountered with fixed beds containing particles of catalyst or sorbent and in particular fixed beds subjected to high temperatures, is that in the region where the particles make contact with the means for containing the bed and/or any member transecting the bed, it has been found that the thermal expansion and contraction of the bed associated with start-up-shutdown procedures can result in a reduction in the bed depth. Consequently, the permeability is greater and hence the flow of gas or liquid through the bed is higher in this region.

This increase in flow through the bed reduces the contact time between fluid and catalyst or sorbent and may result in the problem of fluid by-pass. In the case of a catalytic process where substantially 100% conversion is required, this can result in unreacted species entering the product stream and in the case of a sorbent bed, similarly requiring substantially complete removal of contaminants, this can result in the undesirable presence of contaminants in any downstream process and/or the product.

We have found that the use of a deflector to deflect the flow of fluid away from regions of higher permeability can reduce the problem of by-pass.

Accordingly, the present invention provides a fixed bed containing particles of a catalyst or sorbent through which a process fluid is to pass wherein the bed is bounded by process fluid-impermeable boundary means having a process fluid-impermeable deflector extending away from said boundary and contacting said bed, whereby part of said particulate catalyst or sorbent is disposed between the position where said deflector means contacts the bed and said boundary means from which said deflector means extends.

In the present invention the fixed beds may be subjected to axial and / or radial flow of the process fluid which may be gaseous or liquid. Preferably, the beds of the present invention are subject to axial flow and may be disposed, for example, substantially horizontally in the vessel with gas and/or liquid passing substantially vertically through the bed.

The beds generally comprise particles of catalyst or sorbent supported by a perforate member such as perforate plates, meshes or grids having appropriately-sized holes to prevent passage of the particles therethrough. The bed is typically bounded by the vessel wall or an edge member that extends from the perforate plate for at least the depth of the bed, and which may be attached to the perforate plate, vessel wall or other supporting means for the bed. Such edge members are generally impermeable to process fluid. Where the bed is subjected to elevated temperatures, such edge members may be described as heat-shields as they prevent contact of the hot catalyst particles with e.g. the bed support means or vessel wall.

The beds may be of any shape necessary to provide the required task. Often the bed shape matches that of the cross-section of the vessel in which it is disposed. For example, the bed may be circular, oval, square, rectangular, hexagonal or octagonal. The cross-section width may vary in the range of 0.25 m to 6 m and is preferably 0.5 m to 3.5 m.

The present invention is of particular utility where the beds are relatively thin, i.e. having a depth less than the vessel diameter. Preferably the beds of the present invention are thin beds, typically with a depth between 5 and 500 mm, more preferably between 25 and 300 mm, and most preferably between 25 and 100 mm.

The particles of catalyst or sorbent are in the form of spheres, platelets, cubes, extrudates, cylindrical pellets, granules or other regular or irregular shapes, generally having an aspect ratio, i.e. the largest dimension divided by the smallest dimension, of less than 2. The size of the particles may be uniform or different as required to create the desired contact time between gas or liquid and catalyst or sorbent.

The deflector means of the present invention may be any that results in the deflection of process fluid. Typically, such deflector means may comprise a plate, impermeable to process fluid, extending from the boundary means and into or onto the bed. The thickness of the deflector plate will depend upon a number of factors including the dimensions of the vessel and/or bed but is preferably in the range of 1-25 mm, more preferably 1-10 mm and most preferably 2-5 mm. The deflector plate may be continuous or discontinuous around the boundary means. The deflector plate may be shaped, in particular to deflect the process fluid into or onto the bed of catalyst or sorbent at angles preferably in the range of about 1 – 90

degrees and more preferably 1 – 60 degrees from the direction of flow of the process fluid through the bulk of the bed. The deflector plate so disposed will cover an area of the bed between the boundary means and the position where the deflector contacts the bed. This area may be expressed as a percentage of the total surface area of the bed. The area is between 0.1 and 40%, preferably between 0.1 and 15% and most preferably between 0.3 and 10% in total of the surface area of the bed. In a first embodiment, the deflector extends beneath the surface of the bed, preferably for a distance equal to between 5 and 90% of the thickness of the bed. In a second embodiment the deflector contacts the surface of the bed. It is desirable that the contact with the surface of the bed is maintained through a number of heat-cool cycles. This may be achieved for example by means of a flexible deflector plate or plates, attached to the boundary means by hinging means.

The deflector may be fabricated from any material suitable for use under the conditions of the catalytic or sorbent processes. Typically, the deflector is fabricated from stainless steel, for example 310 stainless steel.

Thus in a circular bed the deflector is disposed preferably in at least part of the circumferential region, or in a rectangular bed the deflector may be along at least part of the outer edge. If columns, pillars or other members transect the bed, it may also be desirable to provide a deflector plate around such members.

As stated above, the deflector may be provided for a fixed bed containing particles of a catalyst. The catalyst may be any that is used disposed in thin beds. Processes that may utilise catalysts in thin beds include for example, ammonia oxidation using, e.g. a particulate cobalt-based catalyst, hydrodesulphurisation using e.g. a cobalt- or nickel-molybdate hydrodesulphurisation catalyst, hydrogen cyanide manufacture, formaldehyde manufacture and partial oxidation reactions, for example for the partial oxidation of hydrocarbons as part of so-called 'gas-to-liquid' (GTL) processes.

The deflector may also be provided for a fixed bed containing particles of a sorbent material. Any sorbent material suitable for the removal of sulphur, mercury, arsenic or compounds thereof, water and/or hydrogen chloride from process fluids, e.g. hydrocarbons, may be used. Examples of sorbents include basic zinc carbonate and copper / zinc oxides for sulphur removal, copper sulphide for mercury and arsenic removal and sodium aluminate or lead carbonate for hydrogen chloride removal.

In particular the present invention is of utility where the bed is subjected to elevated temperatures. The bed temperatures are preferably greater than 100°C, more preferably greater than 200°C, and most preferably greater than 500°C.

The invention will now be described with reference to the accompanying drawings in which;

Figures 1 is diagrammatic cross section of an edge region of a circular fixed catalyst or sorbent bed in accordance with a first example, wherein the deflector is a continuous

circumferential plate attached to the vessel wall, the deflector extending from said vessel wall and into the bed.

Figure 2 is a diagrammatic cross section of an edge region of a fixed catalyst bed in accordance with a second example wherein the deflector comprises a continuous circumferential plate attached to a heat shield fixed to the bed support; and

Figure 3 is a diagrammatic cross section of an edge region of a fixed catalyst bed in accordance with a third example, wherein the deflector comprises a series of plates attached to a heat shield by hinging means.

In each of figures 1, 2 and 3, the fixed beds are drawn so as to have a substantially vertical flow of process fluid through the bulk of the bed in the direction of the arrow 5.

Referring to the drawings, Figure 1 shows a bed of a catalyst or sorbent particles 10 supported upon a perforate member 11 having orifices 12 present to allow the flow of gas or liquid through the bed and contained by an edge member 13. The perforate member is held in position by a lug 14 present on the vessel wall 15. A deflector plate 16 is attached to the vessel wall above the surface of the bed. The deflector plate 16 extends from the vessel wall 15 over the surface of the bed, enters the bed at a position 17, away from the edge region, and extends to a depth approximately 50% of the thickness of the bed at an angle of approximately 15 degrees to the angle of fluid flow through the bulk of the bed.

In Figure 2, a catalyst bed for the oxidation of ammonia is provided by a layer of cobalt-containing catalyst particles 20 supported on a perforate member 21 having orifices 22 to allow the flow of gases through the bed. The perforate member is supported by a lug 23 attached to a bed-support 24. The particles 20 are contained at the edge of the bed by means of a heat-shield 25 attached to bed support 24 that prevents contact of the catalyst particles with said bed support . A deflector plate 26 is attached to the heat shield at a position above the surface of the bed. The deflector plate 26 extends from the heat-shield 25 over the surface of the bed, enters the bed at a position 27, away from the edge region, and extends to a depth approximately 50% of the thickness of the bed at an angle of approximately 10 degrees to the angle of fluid flow through the bulk of the bed.

In Figure 3, a catalyst bed for the oxidation of ammonia is provided by a layer of cobalt-containing catalyst particles 30 supported on a perforate member 31 having orifices 32 to allow the flow of gases through the bed. The perforate member is supported by a lug 33 attached to a bed support 34. The particles 30 are contained at the edge of the bed by means of a heat-shield 35, attached to the bed support 34, that prevents contact of the catalyst particles with said bed support . A deflector plate 36 is attached to the heat shield at a position above the surface of the bed by hinging means 37. The deflector plate 36 extends from said heat shield and contacts with the particles of the bed at a position 38, away from the edge region at an angle of approximately 80 degrees to the angle of fluid flow through the bulk of the bed.

In Figures 1,2, and 3, process fluid fed to the surface of the bed is deflected away from the edge region which represents a region of higher permeability. Deflection of the process

fluid away from this region ensures sufficient contact time at higher throughput between said process fluid and the particles of catalyst or sorbent without bypass of reactants or contaminants than otherwise would be obtainable.

Thus in a preferred embodiment of the present invention a catalyst bed of a cobalt-rare earth perovskite for the oxidation of ammonia as described in WO98/28073, disposed in a reactor of 0.5 - 6 m circular cross-section has a continuous circumferential deflector plate of width 1-20 cm extending from the heat shield and into the bed to a depth between 2-20 mm at an angle of approximately 10-45 degrees to the angle of fluid flow through the bulk of the bed. The catalyst particles are typically cylindrical pellets of 3 mm length and 3 mm diameter and are present in the bed at a depth of 25 – 150 mm. They are supported on a layer of α-alumina pellets of typically 3 - 10 mm diameter of depth 25 – 150 mm. The deflector reduces the amount of unreacted ammonia in the product gas stream.

Claims.

1. A fixed bed containing particles of a catalyst or sorbent through which a process fluid is to pass wherein the bed is bounded by process fluid-impermeable boundary means having a process fluid-impermeable deflector extending away from said boundary and contacting said bed, whereby part of said particulate catalyst or sorbent is disposed between the position where said deflector means contacts the bed and said boundary means from which said deflector means extends.

2. A fixed bed according to claim 1 wherein the catalyst or sorbent is in the form of particles comprising spheres, platelets, cubes, extrudates, cylindrical pellets or granules.

3. A fixed bed according to claim 1 or claim 2 wherein the deflector comprises a plate of thickness 1-25 mm, impermeable to process fluid, extending from the boundary means and contacting with the bed.

4. A fixed fed according to any one of claims 1 to 3 wherein the deflector is shaped to deflect the process fluid into or onto the bed of catalyst or sorbent at angles in the range of about 1 – 90 degrees from the direction of flow of the process fluid through the bulk of the bed.

5. A fixed bed according to any one of claims 1 to 4 wherein the deflector covers an area of the bed between the boundary means and where the deflector enters the bed between 0.1 and 40% in total of the surface area of the bed.

6. A fixed bed according to any one of claims 1 to 5 disposed in a vessel wherein the deflector is a continuous plate attached to the vessel wall, the deflector extending from said vessel wall and into the bed.

7. A fixed bed according to any one of claims 1 to 5 disposed in a vessel upon bed supporting means wherein the deflector comprises a continuous plate or plates attached to a heat shield fixed to the bed supporting means.

8. The use of a fixed bed according to any one of claims 1 to 7 in a process operated with bed temperature greater than 100°C.

9. The use of a fixed sorbent bed according to any one of claims 1 to 8 for the removal of materials containing sulphur, mercury, arsenic, water and/or hydrogen chloride from process fluids.

10. The use of a fixed catalyst bed according to any one of claims 1 to 8 in processes for ammonia oxidation, hydrodesulphurisation, hydrogen cyanide manufacture, formaldehyde manufacture or partial oxidation of hydrocarbons.

Fig.1.

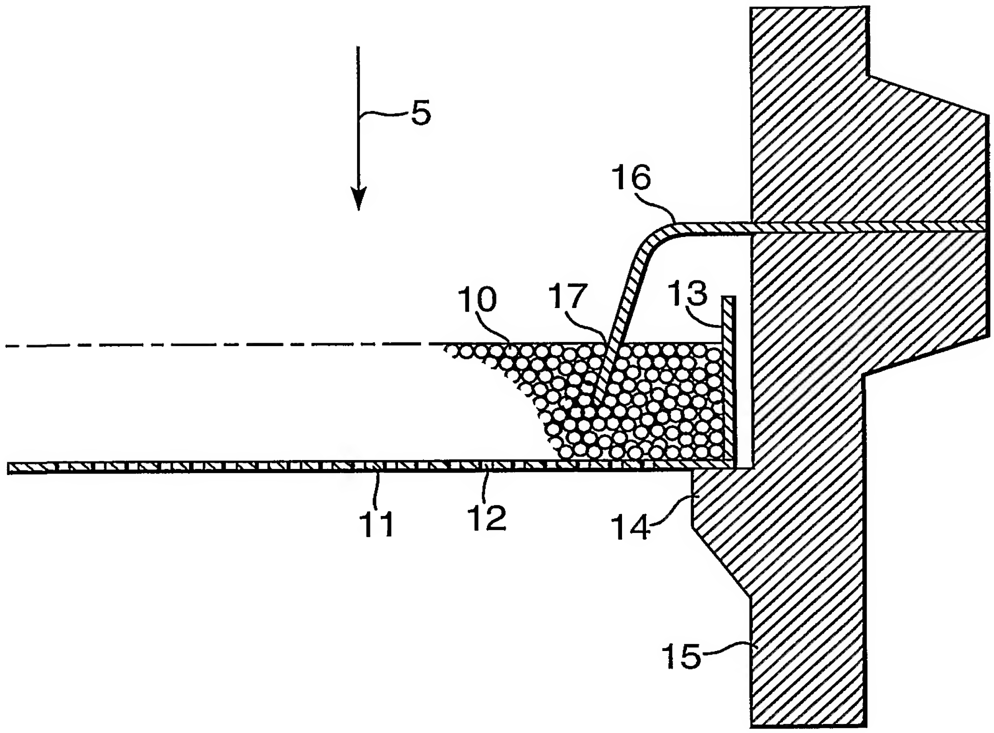


Fig.2.

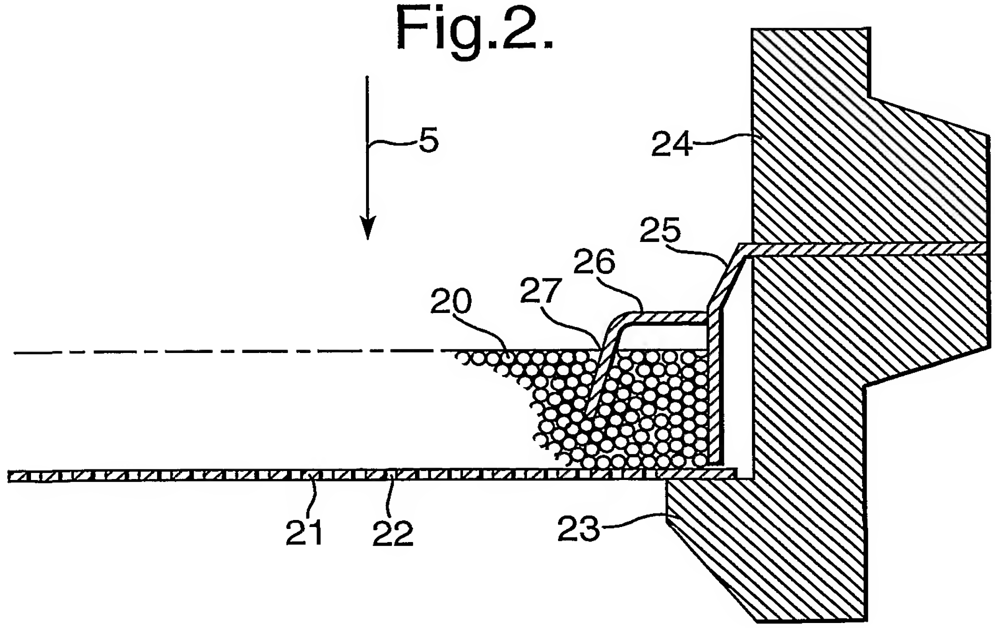
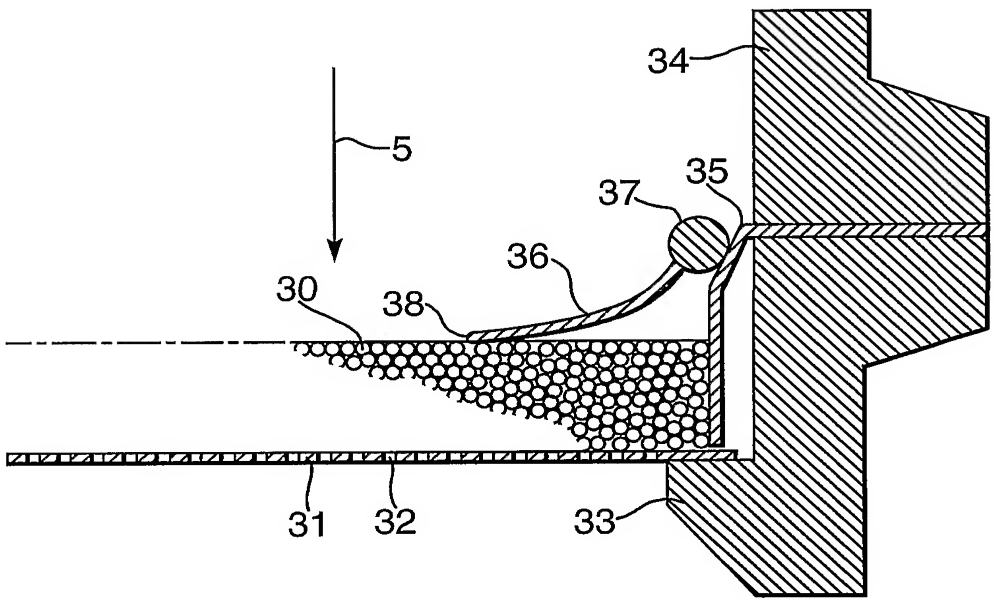


Fig.3.



INTERNATIONAL SEARCH REPORT

Internatio plication No
PCT/GB 02/02520

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01J8/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 514 205 A (AWAJI TOSHIO) 7 May 1996 (1996-05-07) abstract column 1, line 46 -column 2, line 32 column 5, line 26 - line 37 column 10, line 24 - line 29 column 12, line 1 - line 61; figure 1 ---	1-6,9,10
X	US 5 882 385 A (BOSQUAIN MAURICE ET AL) 16 March 1999 (1999-03-16) abstract column 1, line 14 - line 25 column 1, line 36 - line 42 column 1, line 65 -column 4, line 20; figures --- -/--	1-6,9,10

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 September 2002	21/10/2002

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 86 215 B (PINTSCH BAMAG, AG) 13 February 1959 (1959-02-13) column 1, line 1 - line 12 figure 2 ---	1-6
A	EP 0 293 523 A (UOP INC) 7 December 1988 (1988-12-07) column 9, line 15 - line 45 -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

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